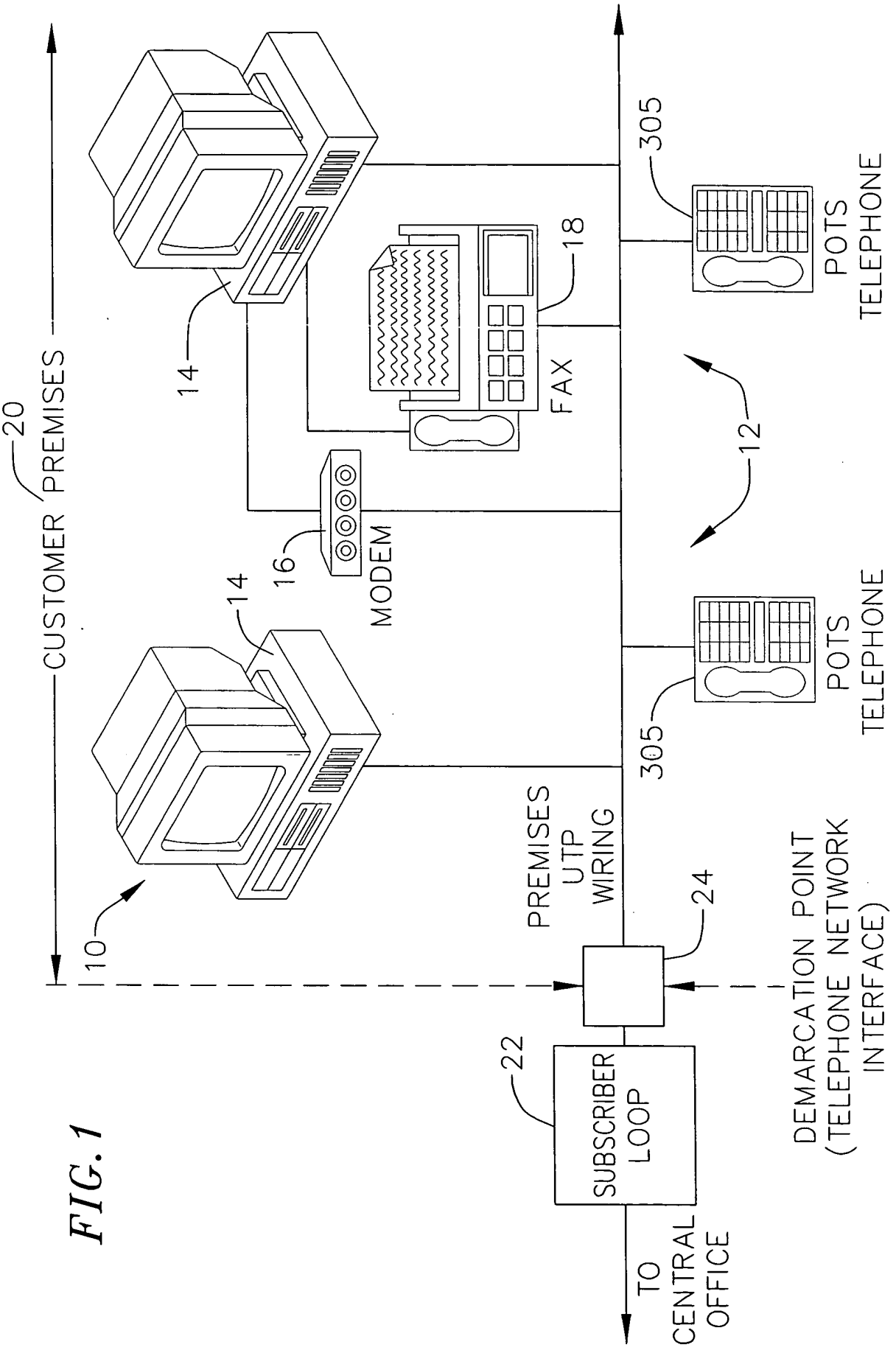

20
CUSTOMER PREMISES
14
14
18
FAX
16
MODEM
305
POTS TELEPHONE
305
POTS TELEPHONE
12
10
PREMISES UTP WIRING
24
DEMARCATION POINT (TELEPHONE NETWORK INTERFACE)
22
SUBSCRIBER LOOP
TO CENTRAL OFFICE

FIG. 1

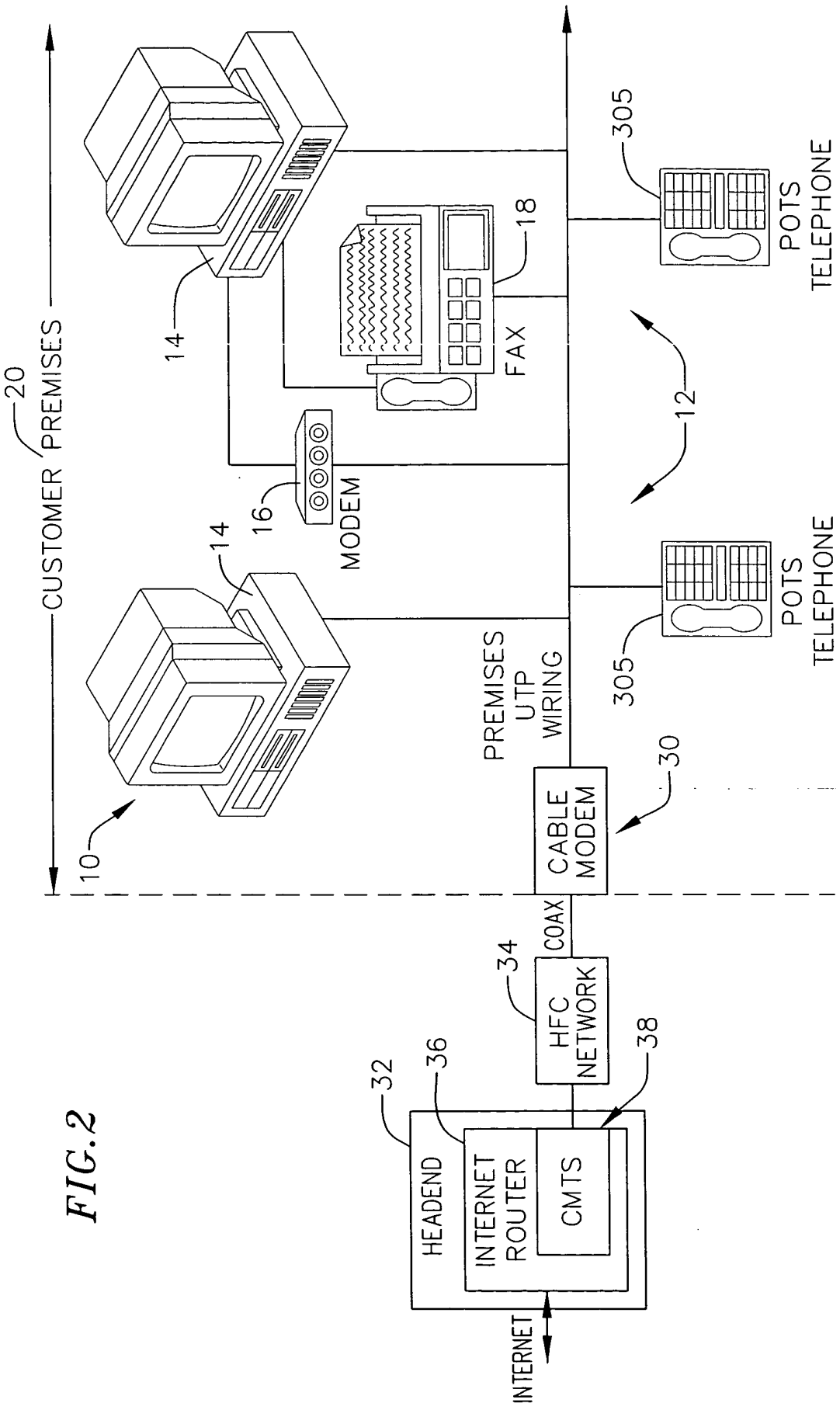
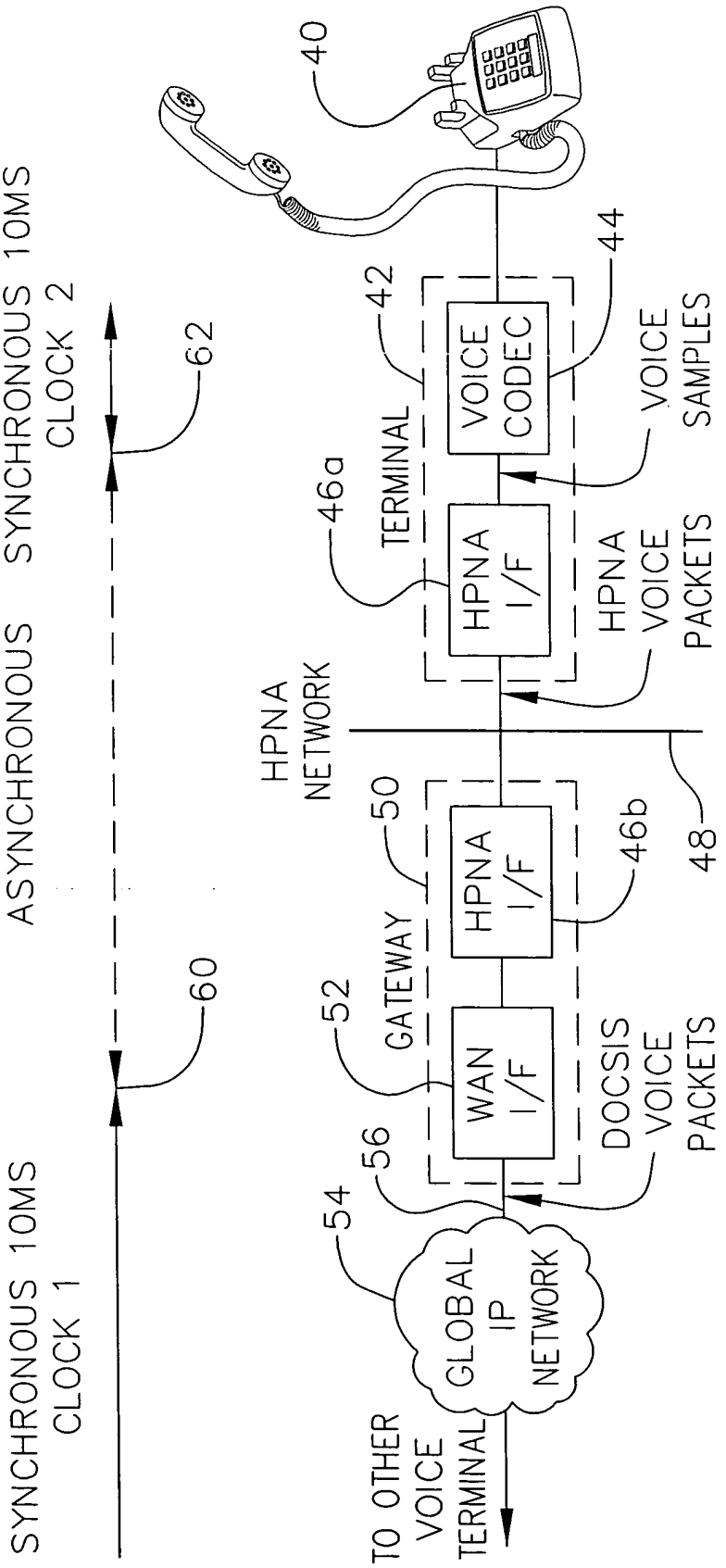

CUSTOMER PREMISES
20
10
14
14
16
MODEM
18
FAX
12
305
POTS TELEPHONE
305
POTS TELEPHONE
PREMISES UTP WIRING
CABLE MODEM
30
COAX
34
HFC NETWORK
38
36
32
HEADEND
INTERNET ROUTER
CMTS
INTERNET

FIG. 2

FIG. 3


SYNCHRONOUS 10MS CLOCK 1
ASYNCHRONOUS
SYNCHRONOUS 10MS CLOCK 2
60
62
40
42
44
TERMINAL
VOICE CODEC
VOICE SAMPLES
46a
HPNA I/F
HPNA VOICE PACKETS
HPNA NETWORK
48
50
GATEWAY
52
WAN I/F
HPNA I/F
46b
54
56
DOCSIS VOICE PACKETS
GLOBAL IP NETWORK
TO OTHER VOICE TERMINAL

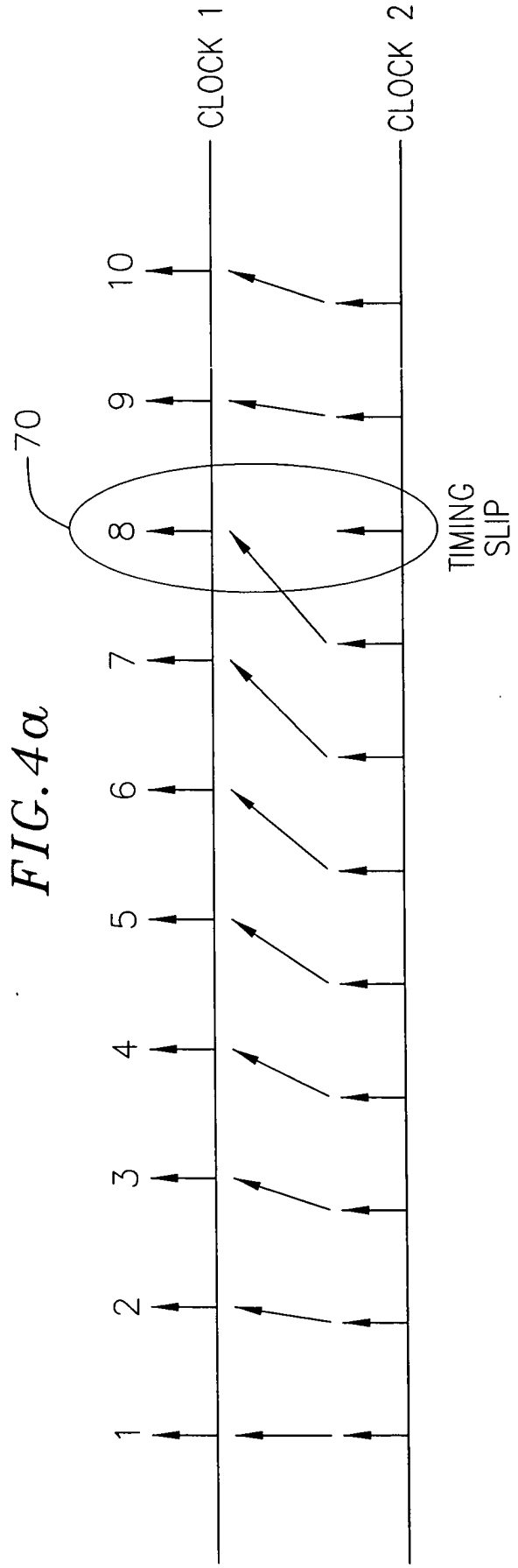

CLOCK 1
CLOCK 2
1
2
3
4
5
6
7
8
9
10
70
TIMING SLIP

FIG. 4a

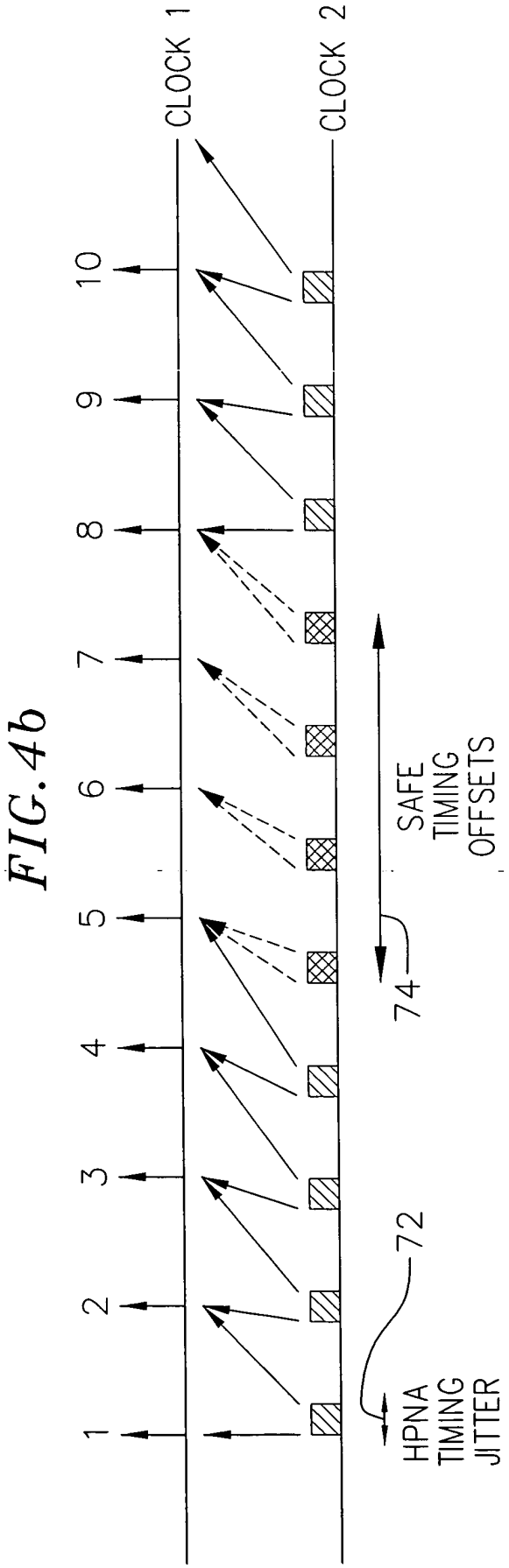

CLOCK 1
CLOCK 2
1
2
3
4
5
6
7
8
9
10
SAFE TIMING OFFSETS
74
72
HPNA TIMING JITTER

FIG. 4b

FIG. 5

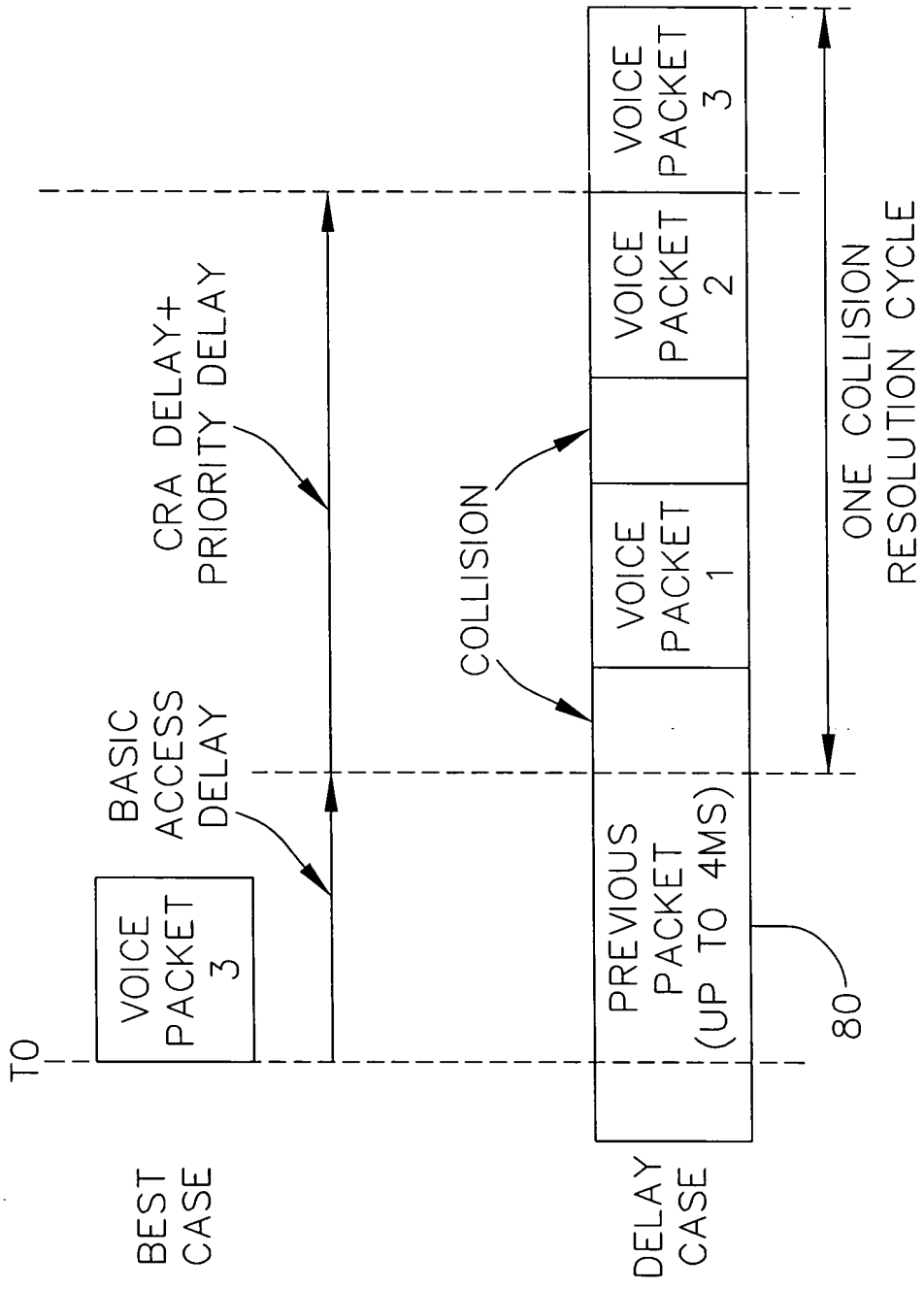
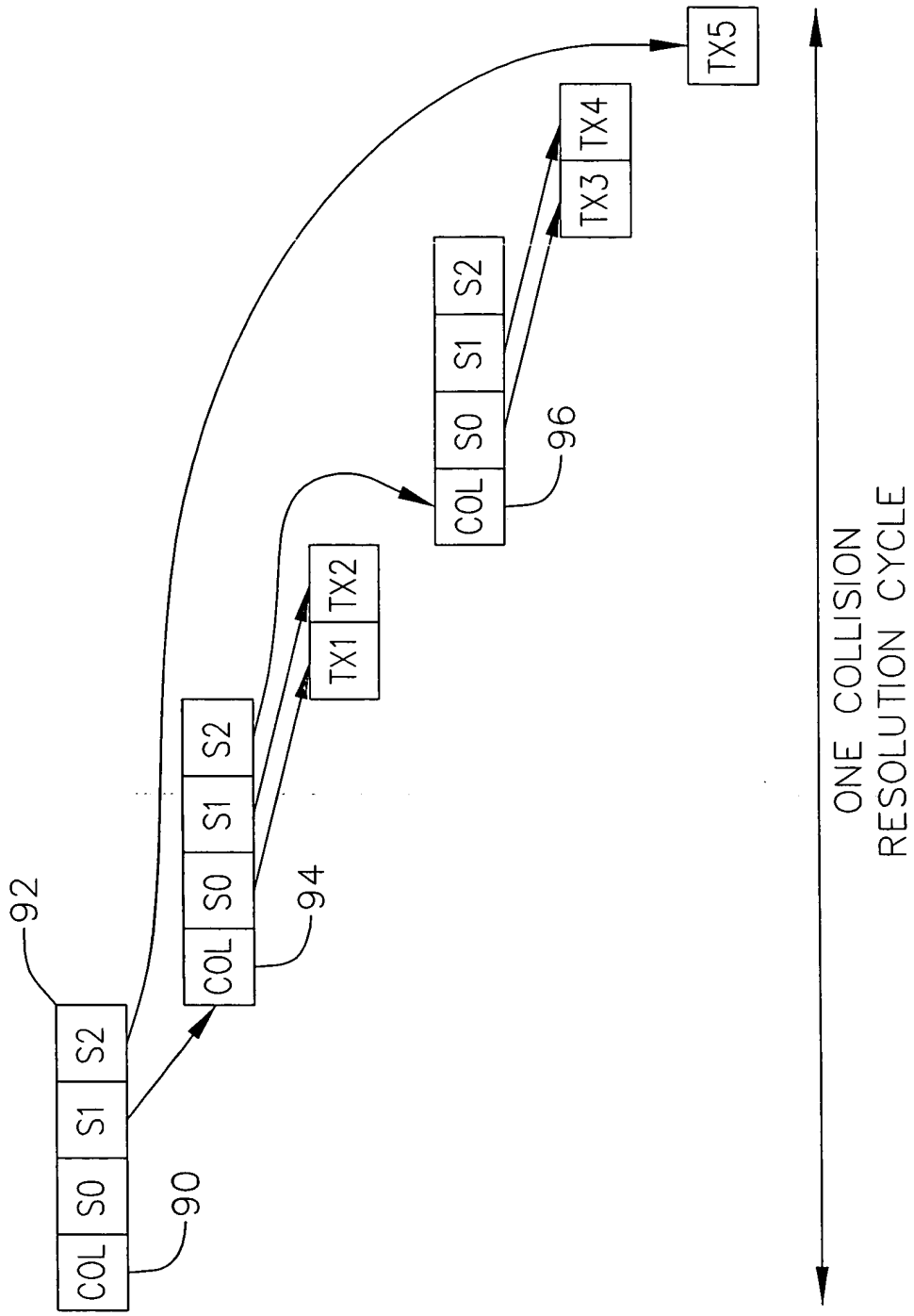

T0
VOICE PACKET 3
BASIC ACCESS DELAY
CRA DELAY+ PRIORITY DELAY
BEST CASE
COLLISION
PREVIOUS PACKET (UP TO 4MS)
VOICE PACKET 1
VOICE PACKET 2
VOICE PACKET 3
80
DELAY CASE
ONE COLLISION RESOLUTION CYCLE

FIG. 6


COL
S0
S1
S2
90
92
94
96
TX1
TX2
TX3
TX4
TX5
ONE COLLISION RESOLUTION CYCLE

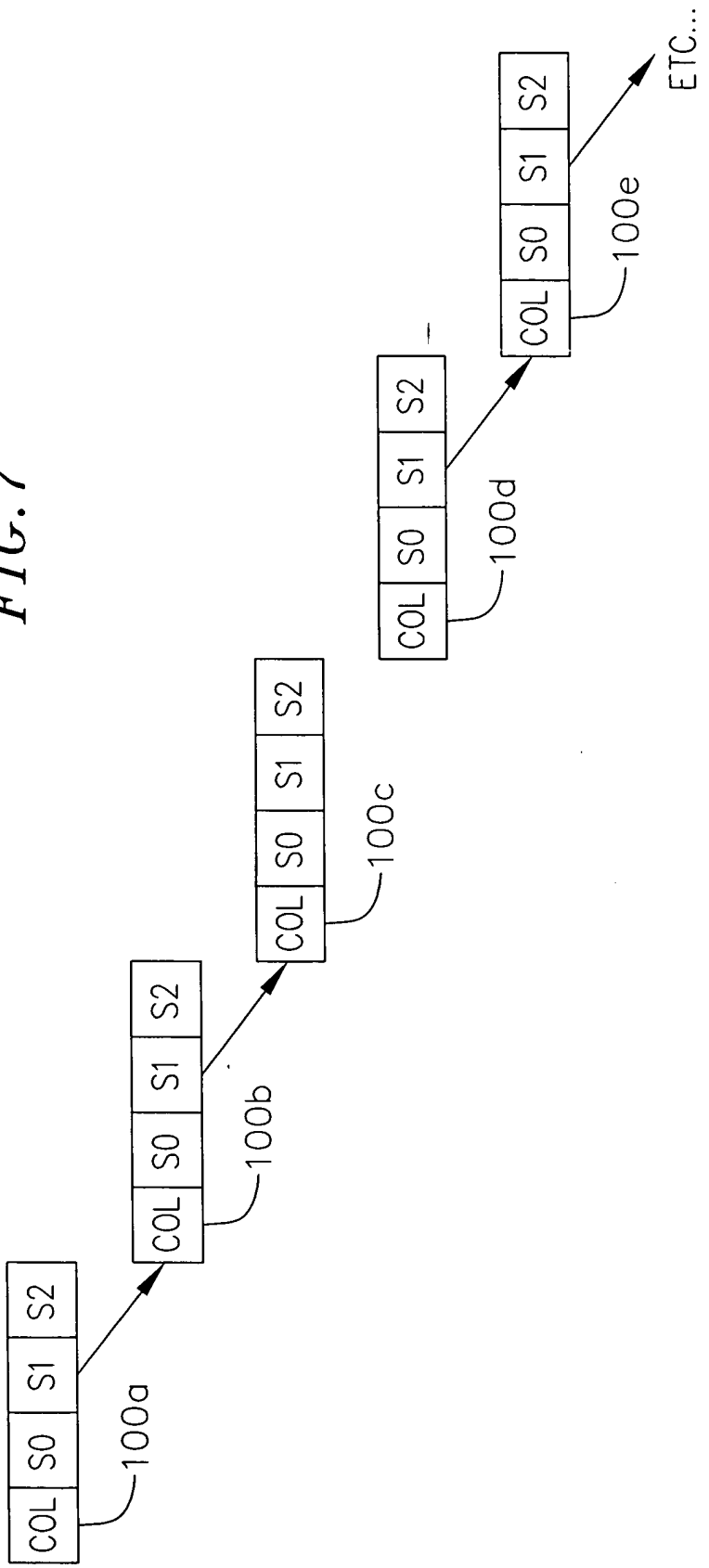


FIG. 7

FIG.8

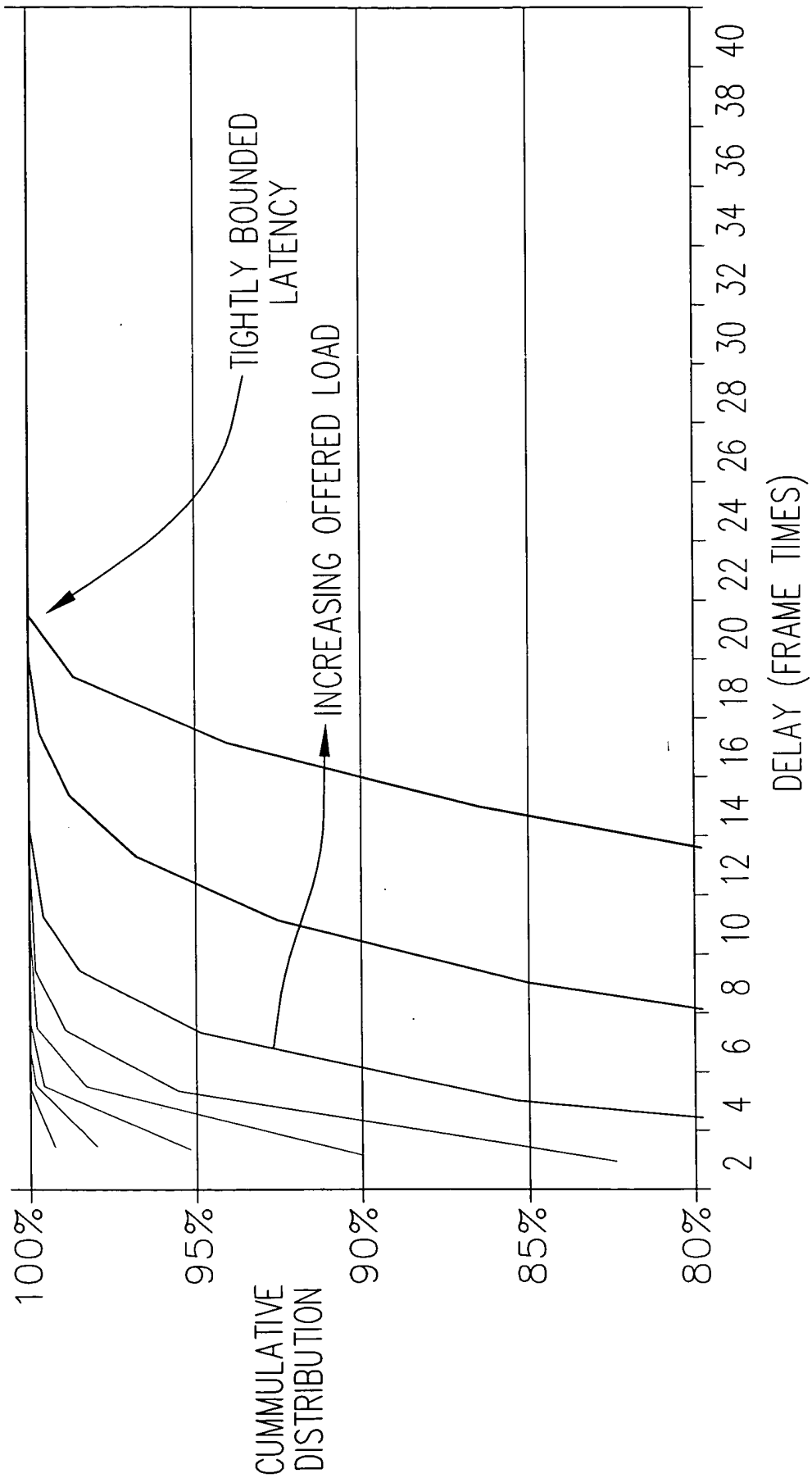

TIGHTLY BOUNDED LATENCY
INCREASING OFFERED LOAD
CUMMULATIVE DISTRIBUTION
100%
95%
90%
85%
80%
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40
DELAY (FRAME TIMES)

FIG. 9

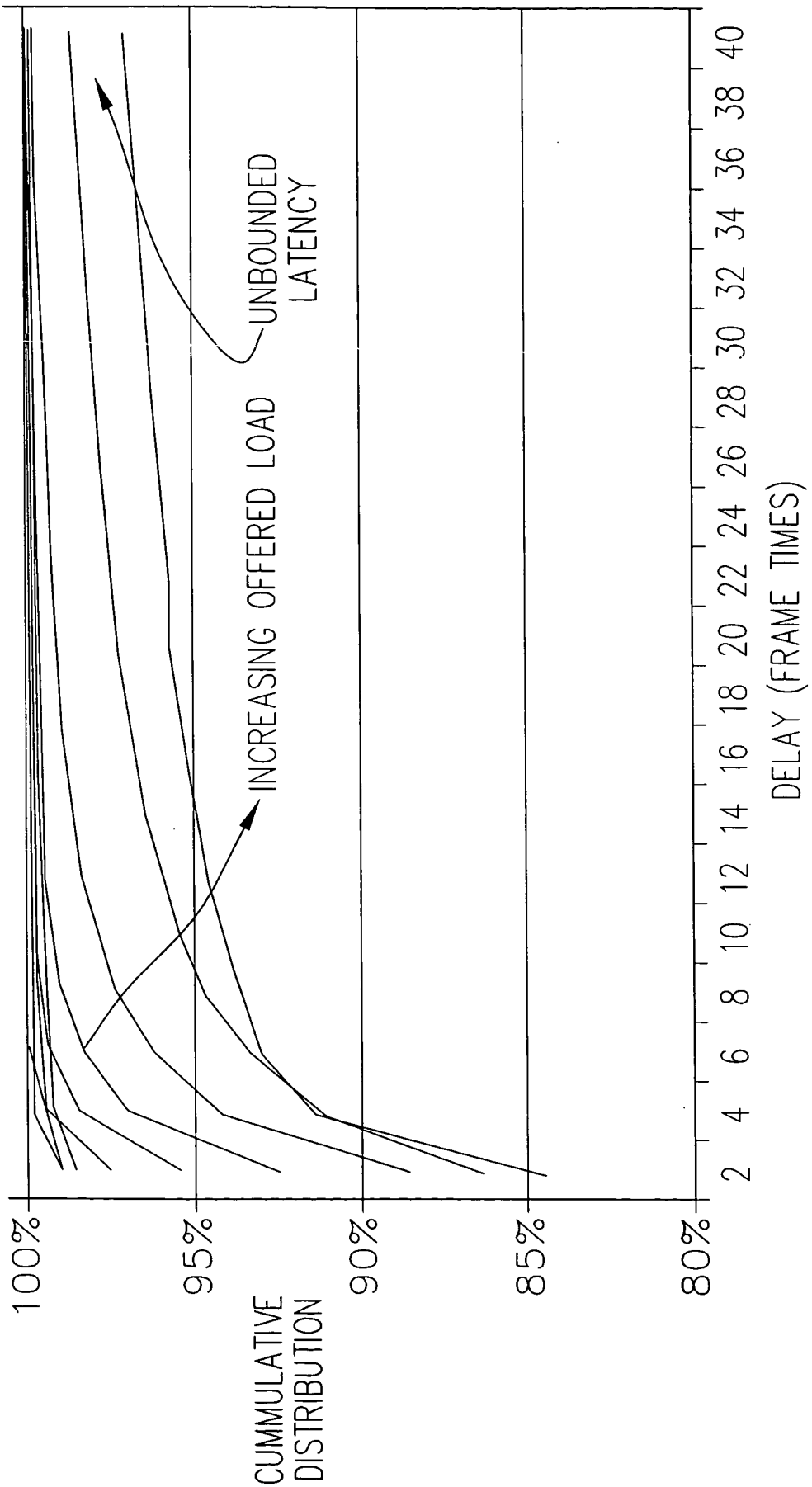

100%
95%
90%
85%
80%
CUMMULATIVE DISTRIBUTION
2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40
DELAY (FRAME TIMES)
INCREASING OFFERED LOAD
UNBOUNDED LATENCY

FIG. 10

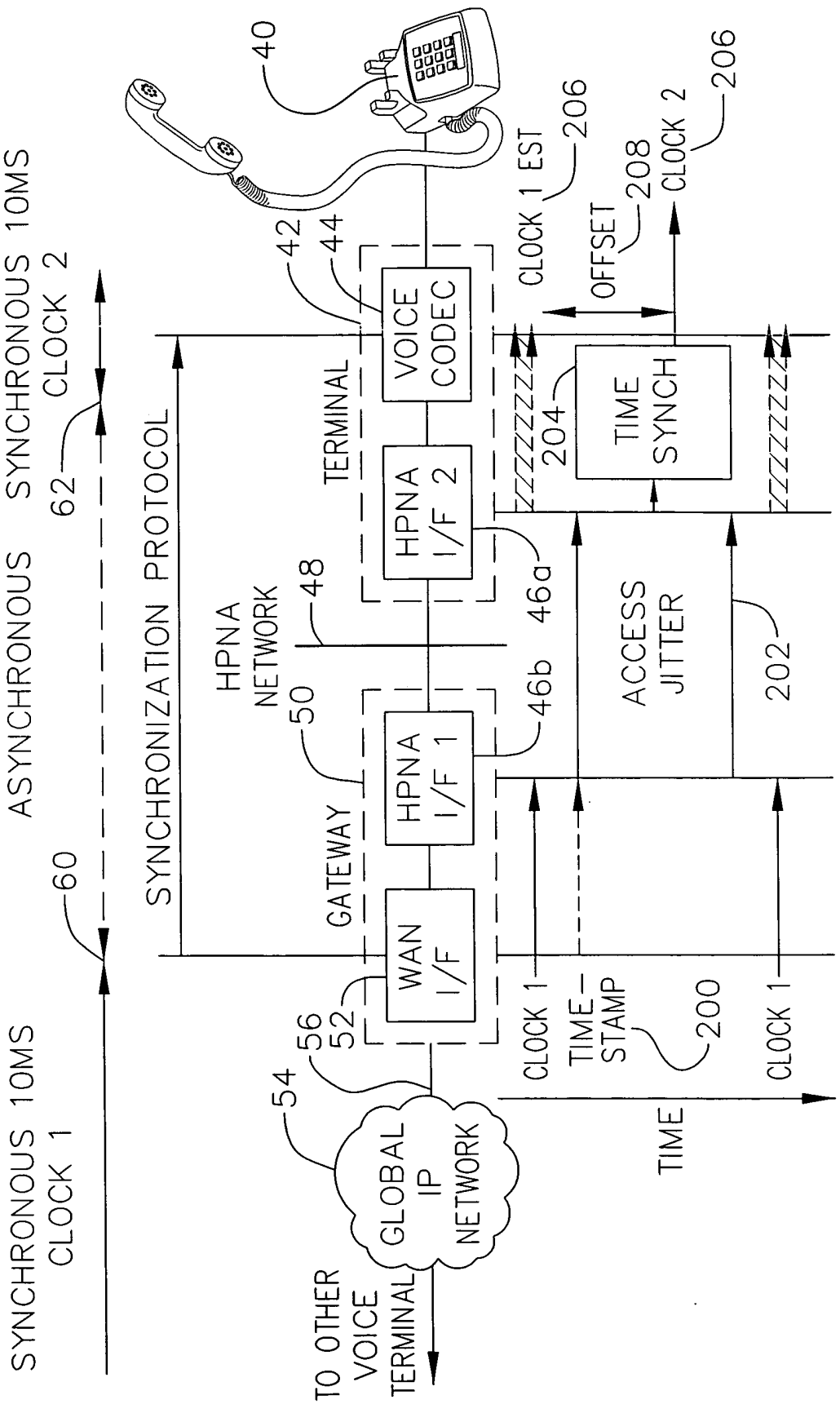

SYNCHRONOUS 10MS CLOCK 1
ASYNCHRONOUS SYNCHRONOUS 10MS CLOCK 2
60
62
SYNCHRONIZATION PROTOCOL
HPNA NETWORK
48
GATEWAY
50
WAN I/F
HPNA I/F 1
HPNA I/F 2
TERMINAL
VOICE CODEC
40
42
44
46a
46b
54
56
52
GLOBAL IP NETWORK
TO OTHER VOICE TERMINAL
CLOCK 1
TIME-STAMP
200
TIME
CLOCK 1
ACCESS JITTER
202
TIME SYNCH
204
CLOCK 1 EST
206
OFFSET
208
CLOCK 2
206

FIG. 11

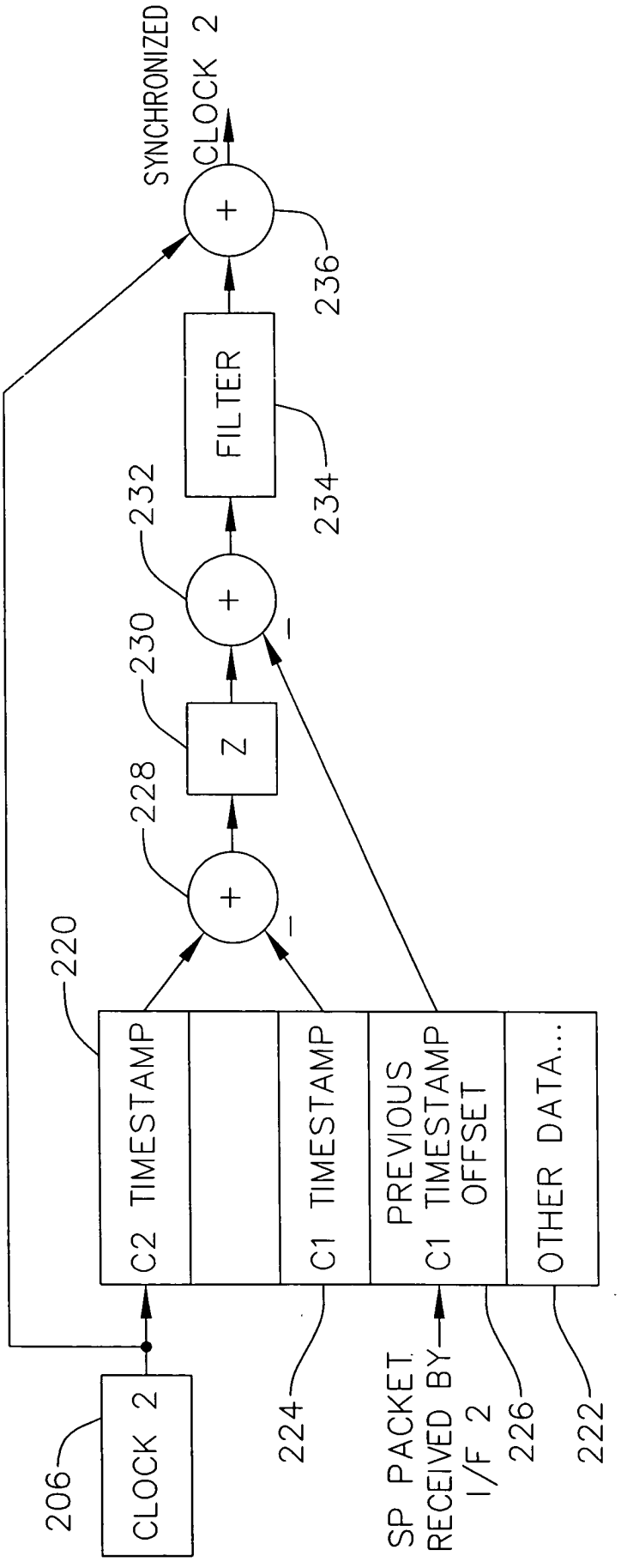

SYNCHRONIZED CLOCK 2
236
FILTER
234
232
230
Z
228
220
C2 TIMESTAMP
C1 TIMESTAMP
PREVIOUS C1 TIMESTAMP OFFSET
OTHER DATA...
CLOCK 2
206
224
SP PACKET RECEIVED BY I/F 2
226
222

FIG. 12

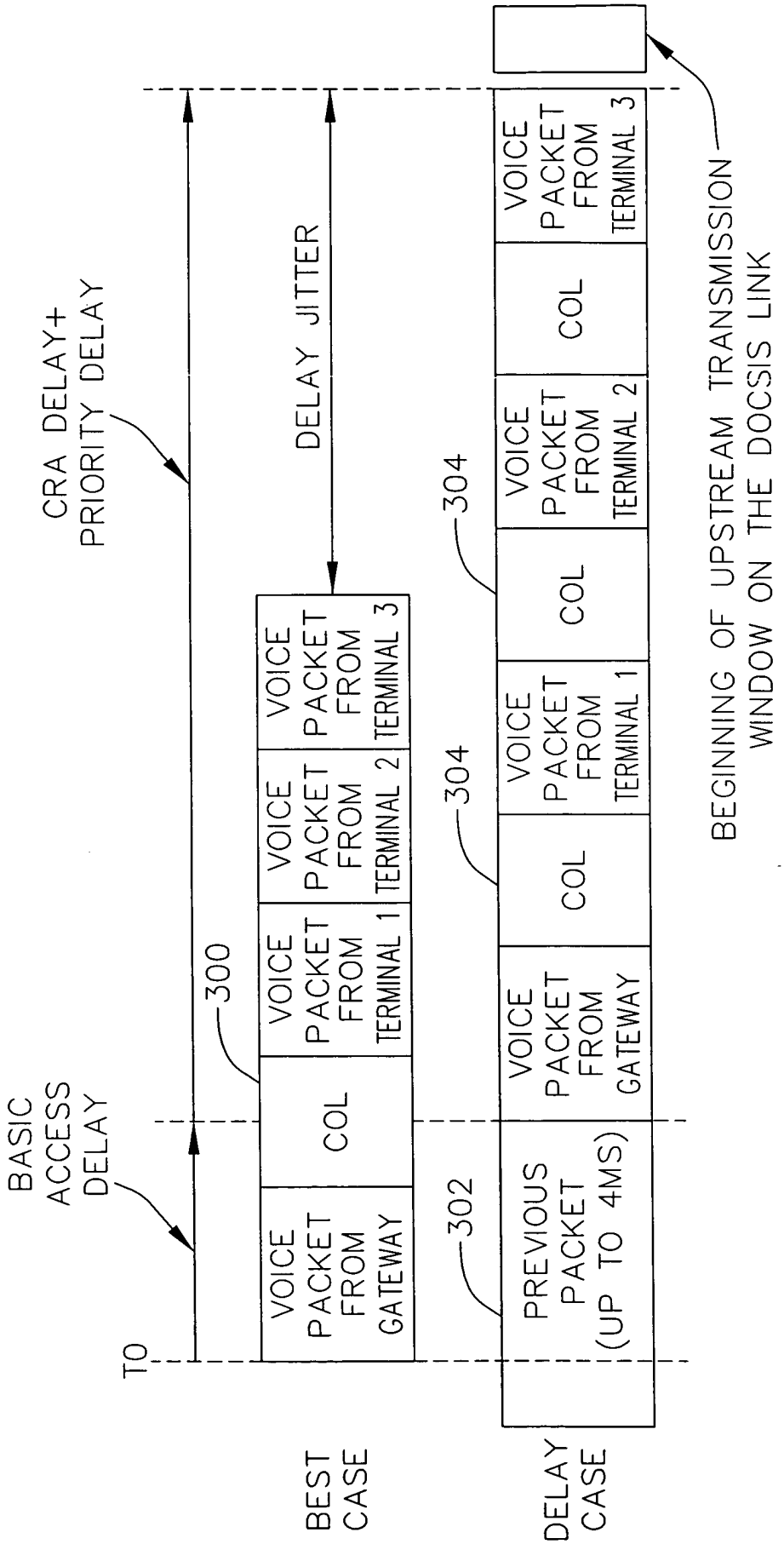

BASIC ACCESS DELAY
CRA DELAY+ PRIORITY DELAY
DELAY JITTER
T0
300
302
304
304
VOICE PACKET FROM GATEWAY
COL
VOICE PACKET FROM TERMINAL 1
VOICE PACKET FROM TERMINAL 2
VOICE PACKET FROM TERMINAL 3
PREVIOUS PACKET (UP TO 4MS)
VOICE PACKET FROM GATEWAY
COL
VOICE PACKET FROM TERMINAL 1
COL
VOICE PACKET FROM TERMINAL 2
COL
VOICE PACKET FROM TERMINAL 3
BEST CASE
DELAY CASE
BEGINNING OF UPSTREAM TRANSMISSION WINDOW ON THE DOCSIS LINK

FIG. 13

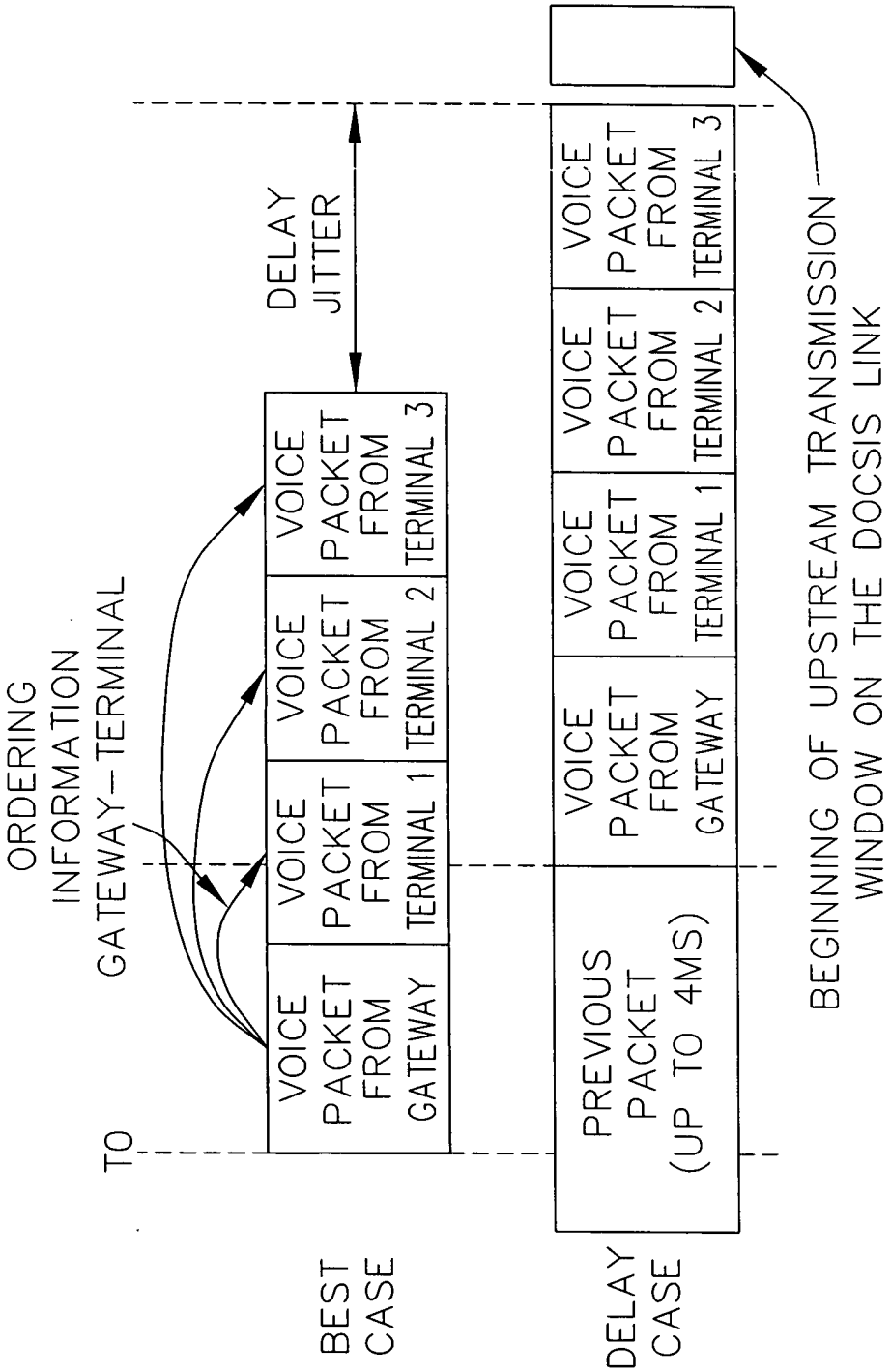

ORDERING INFORMATION GATEWAY—TERMINAL
TO
DELAY JITTER
VOICE PACKET FROM GATEWAY
VOICE PACKET FROM TERMINAL 1
VOICE PACKET FROM TERMINAL 2
VOICE PACKET FROM TERMINAL 3
PREVIOUS PACKET (UP TO 4MS)
VOICE PACKET FROM GATEWAY
VOICE PACKET FROM TERMINAL 1
VOICE PACKET FROM TERMINAL 2
VOICE PACKET FROM TERMINAL 3
BEST CASE
DELAY CASE
BEGINNING OF UPSTREAM TRANSMISSION WINDOW ON THE DOCSIS LINK

FIG. 14

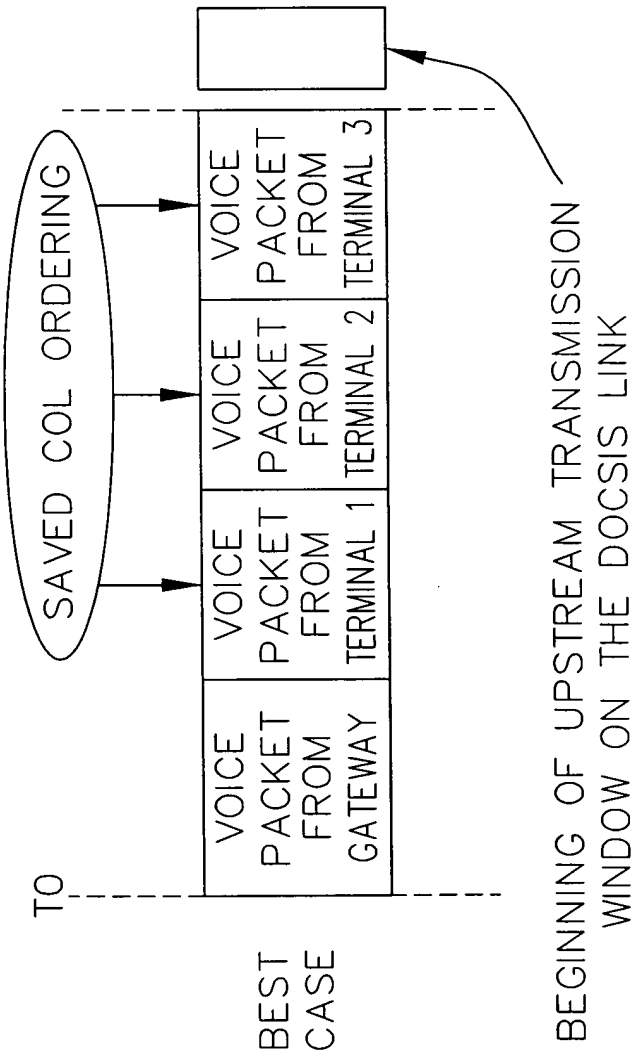

SAVED COL ORDERING
VOICE PACKET FROM GATEWAY
VOICE PACKET FROM TERMINAL 1
VOICE PACKET FROM TERMINAL 2
VOICE PACKET FROM TERMINAL 3
T0
BEST CASE
BEGINNING OF UPSTREAM TRANSMISSION WINDOW ON THE DOCSIS LINK

FIG. 15

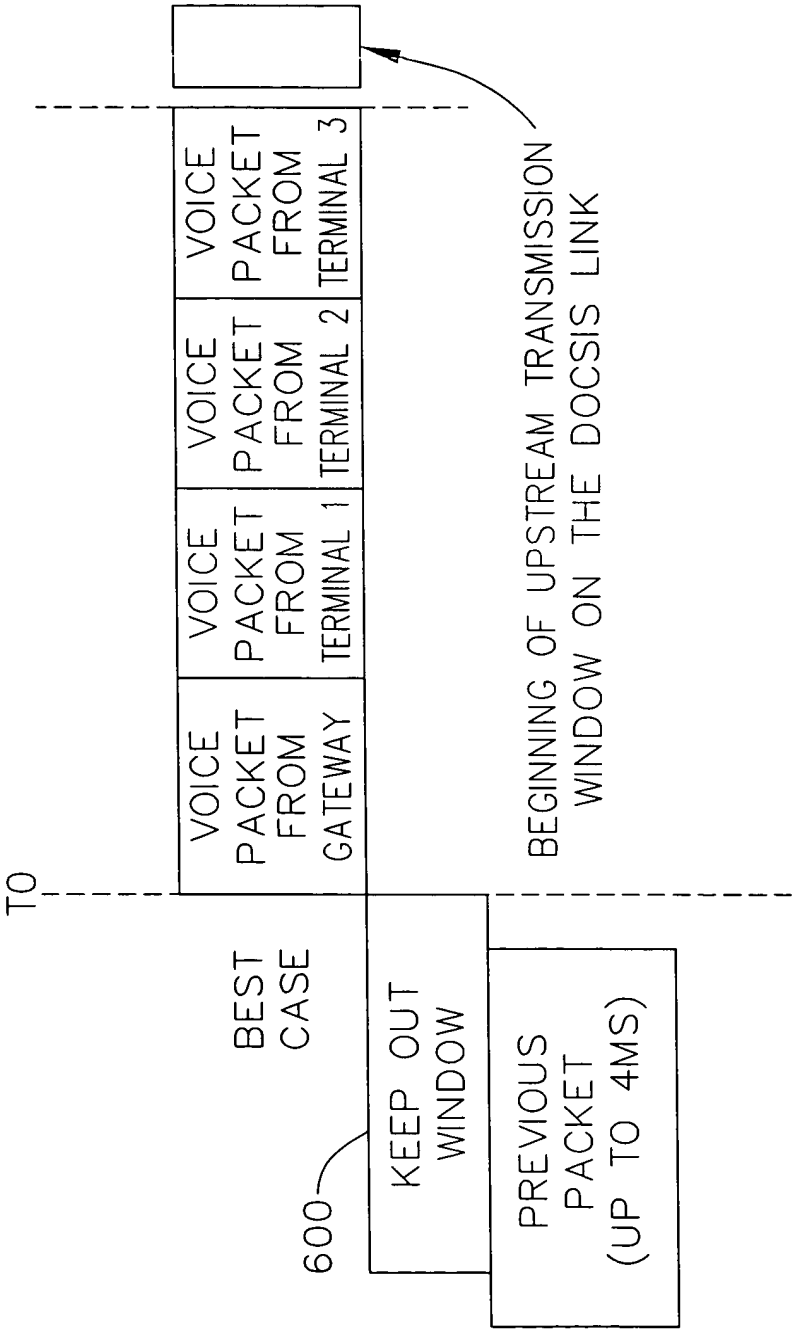

T0
VOICE PACKET FROM GATEWAY
VOICE PACKET FROM TERMINAL 1
VOICE PACKET FROM TERMINAL 2
VOICE PACKET FROM TERMINAL 3
BEGINNING OF UPSTREAM TRANSMISSION WINDOW ON THE DOCSIS LINK
BEST CASE
600
KEEP OUT WINDOW
PREVIOUS PACKET (UP TO 4MS)

FIG. 16

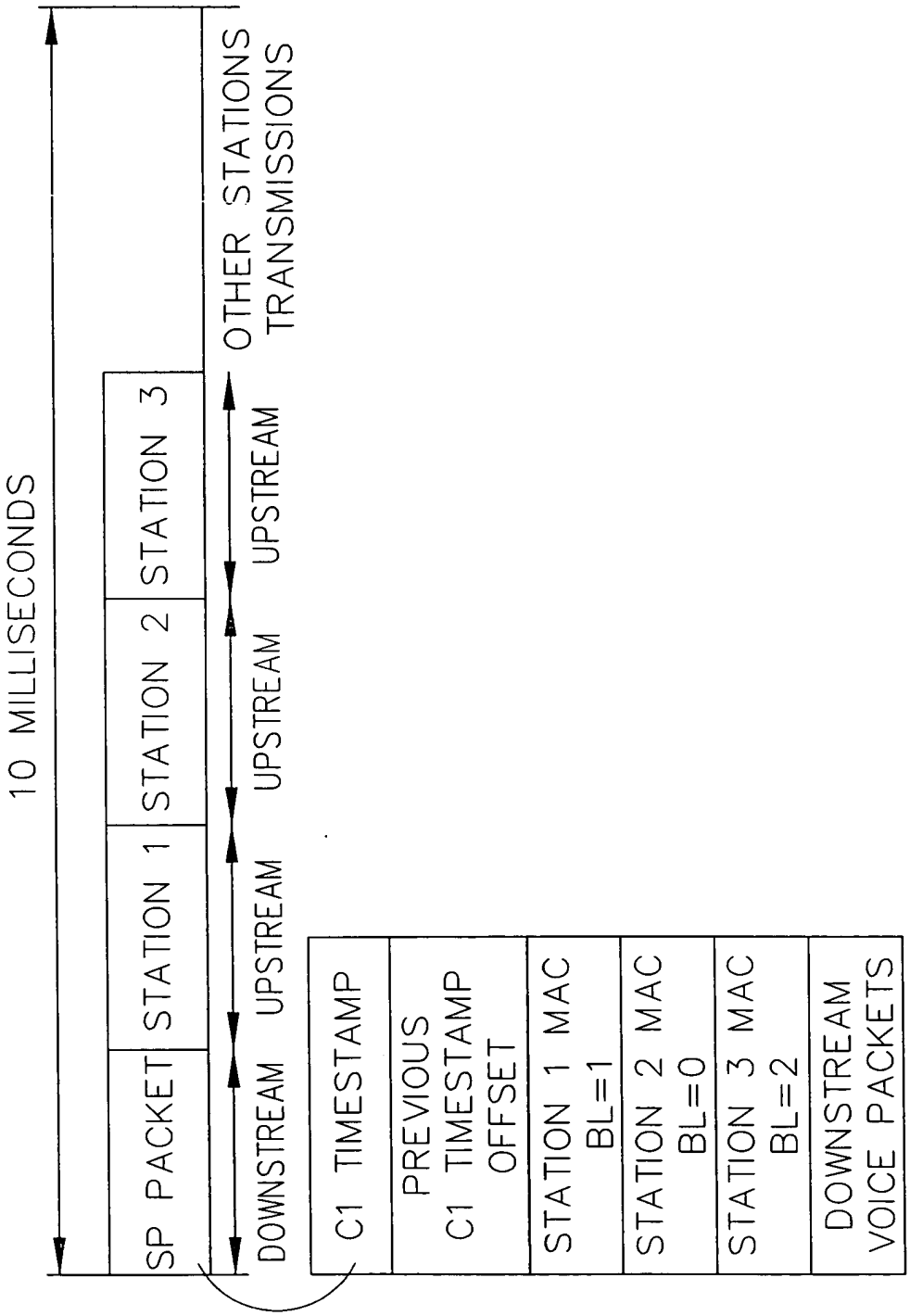
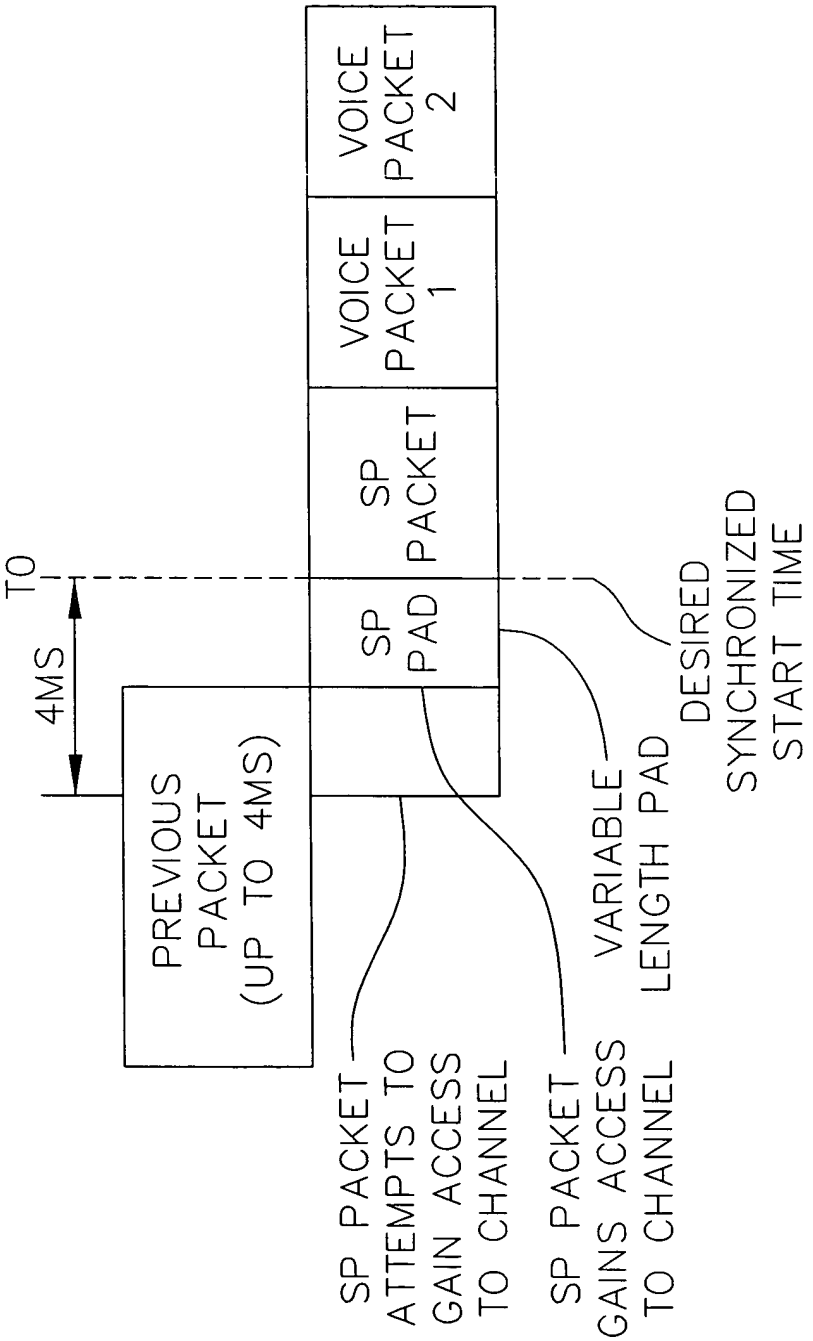

10 MILLISECONDS
SP PACKET
STATION 1
STATION 2
STATION 3
OTHER STATIONS TRANSMISSIONS
DOWNSTREAM
UPSTREAM
UPSTREAM
UPSTREAM
C1 TIMESTAMP
PREVIOUS C1 TIMESTAMP OFFSET
STATION 1 MAC BL=1
STATION 2 MAC BL=0
STATION 3 MAC BL=2
DOWNSTREAM VOICE PACKETS

FIG. 17


TO
4MS
PREVIOUS PACKET (UP TO 4MS)
SP PAD
SP PACKET
VOICE PACKET 1
VOICE PACKET 2
SP PACKET ATTEMPTS TO GAIN ACCESS TO CHANNEL
SP PACKET GAINS ACCESS TO CHANNEL
VARIABLE LENGTH PAD
DESIRED SYNCHRONIZED START TIME